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THE JOURNAL OF THE JANAF FUZE COMMITTEE

(JOINT ARMY-NAVY-AIR FORCE)

SCOPE, PURPOSE AND USE OF MILITARY STANDARDS FOR FUZES

Serial No. 24

15 FEBRUARY 1962

PREPARED BY A.W.BALDWIN
U.S.NAVAL ORDNANCE LABORATORY, WHITE OAK

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ABSTRACT

Military Standards for use in development and production of fuzes have been prepared by the Joint Army, Navy, and Air Force (JANAF) Fuze Committee. Those field and laboratory tests which are applicable to a specific type of fuze or to several types of fuzes and are frequently used have been published so that the tests may be conducted in the same manner regardless of where the work is performed. Test laboratories using the standard tests have produced data which can be interpreted by all other fuze laboratories, and thus the repetition of similar tests has been reduced when a fuze developed by one service is adopted by another military service.

Special tests for unusual fuzes or components are still necessary and the Committee does not wish to stifle or inhibit the generation and use of such tests. The Military Standard tests are mandatory only after competent personnel have reviewed the applicability of the test for the particular fuze and have directed its use. This article also points out that there are not standard tests for all needs nor are all published standard tests applicable to any one fuze.

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INTRODUCTION

The primary purpose of the Joint Army, Navy, Air Force Fuze Committee is to effectively ultilize available manpower, materials and funds for the design, development, evaluation and production engineering of fuzes. The Committee has accomplished this purpose in part by the preparation and publication of tests for safety and operability, known as the Military Standard 300 series. Technical reports on procedures, test equipment, test technology, fuze design and related subjects are published as Journal Articles. Users of any of these publications are encouraged to read all of the Military Standard 300 series and the Journal Articles to develop an appreciation of the continuity and relationship of the publications. Furthermore, the users of these standards should become thoroughly familiar with the meaning and intent of the promulgation in this series which states: "This standard has been approved by the Department of Defense and is mandatory for use by the Departments of the Army, the Navy and the Air Force, effective (date)." The use of a standard is mandatory only after its selection for use on a specific fuze has been made by competent authority. This matter is discussed in greater detail in the ensuing paragraphs. The information contained in the Journal of the JANAF Fuze Committee, Introduction to the Use of Military Standards, Serial No. 01.0, 23 August 1955, reference (a), has been included in this article but a review of the referenced article will confirm for the reader the consistency of Committee policies.

Even though each service had designed its munitions to meet the military requirements of the particular logistical and tactical employment for the item, the exchange of munitions and munition designs between the services on such items as fuzes increased in volume following World War II. Logically, the most economical and expeditious system for producing a finished service item is to design the item to meet only its specific requirement. Although the military requirements of each service are quite similar, they do differ to some extent. As examples, the Navy lands aircraft using arresting landing gear. This equipment places a greater deceleration loading on the munition and the system for attaching the munition to the aircraft than is encountered in conventional runway landing. When an aircraft returns with unexpended externally-carried ammunition, an additional environment peculiar to this operation is the possible collision of the munition with the fantail or the superstructure of the ship. In another situation, the loading of munitions into the hold of a ship creates the possibility of a reasonably long free drop onto a steel deck. This particular environment brought about the Forty-Foot Drop Test which is well known to fuze designers. The natural environments create problems of differing nature for each service. The Army requires a fuze which will operate satisfactorily under conditions of long exposure to the extreme temperatures encountered on land. These requirements are set forth in AR-705-15, reference (b). The Navy has the same problem for fuzes intended for use by the Marines. For shipboard armament fuzes, the temperature extremes are more moderate but other factors such as a corrosive atmosphere may be more intense. The limits are set forth in NavOrd OS 6341, reference (c). An Air Force munition can reasonably be expected to encounter dust storms prior to becoming airborne, far in excess both with respect to intensity and frequency of any the Navy aircraft-carried munitions might experience.

Even though the environments may appear to be different, the basic parameters bear a great similarity but differ in amplitude, frequency, or duration. The problem encountered by the environmental engineers of the various services has been to recognize the similarity. Tests which have been used to simulate a particular military requirement and environment by one service frequently will differ greatly from those used for a similar environment by another service. Even so, the purpose and criteria may be essentially the same. Another problem has been to correlate information obtained from these various tests and relate this information to safety, operability and storage.

Lack of correlatable data was always noticeable when one service adopted ammunition from another service. The project engineer had the responsibility of studying test results from the originating service to determine the extent to which the munition would meet the military requirements in the new application. Frequently upon study of the test results, correlatable factors were found not to exist, and the tests conducted by one service appeared to be quite different from those of another service. In this case, many additional tests were conducted to determine that the design would meet safety and operability requirements.

ORIGIN OF JANAF FUZE COMMITTEE

The need for correlation within the area of design of fuzes was recognized by the services and thus to assist in eliminating some of the problems, the Joint Army-Navy Fuze Committee was established in 1947 by the Chief of the Bureau of Naval Weapons (then Bureau of Ordnance) and the Chief of Ordnance (Army). The Air Force became a party to this committee on 23 April 1955. The mission of the committee was to advise the chiefs of the services on problems of joint interest pertaining to technical matters relating to research, design, development, and production engineering of fuzes, and particularly to give assurance that every opportunity for profitable joint action was explored. Particular emphasis was to be placed on preventing duplication of effort by the services and stressing importance of developing items suitable for common usage by the three services. A further goal was the standardization of safety and performance requirements and testing procedures.

The Main Committee was authorized by its charter to establish subcommittees essential to its operation.* Currently there are five subcommittees, namely, the Laboratory Tests, Electronic Systems, Mechanical and Electromechanical Systems, Explosive Components, and Field Tests Subcommittees. Each of these subcommittees has been very active in studying problems of joint interest, with particular emphasis on the solution of the technical aspects of these problems. This information has been disseminated in meetings held for interested personnel. by correspondence, Journal Articles, and Military Standards in the 300 series. The numbers 300 to 349 have been set aside for Military Standards for use in development of fuzes. The numbers 350 to 399 have been reserved for Military Standards for use in production of fuzes. The Military Standards published to date are listed in Table 1.

MILITARY STANDARDS IN THE 300 SERIES

The needs and reasons for the Standards, as envisioned by the charter members of the committee, have remained quite constant throughout the life of this committee. The Standards are established so that any laboratory may conduct a test using identical methods and thus obtain results which can be used by other laboratories. The criteria for passing a test have been established for universal usage with the expectation that the data from all test laboratories can be correlated. The major advantage in the use of these Standards is that data obtained may be exchanged with other laboratories. As an example, a Jumble Test of a fuze at one laboratory in accordance with "Jumble Test for use in Development of Fuzes",

*Information on the committee activities, aims and accomplishments was presented in an article, <u>Fuze Testing Standards</u>, Ordnance, p 1050, 3 pp, May-June 1954, reference (d).

MIL-STD-301, will yield data which can be used by another laboratory or service. The committee has maintained a periodic review of the published Standards and prepared revisions when appropriate. Additional Standards are prepared as studies are completed.

Preparation of Standards. Representatives from each of the three services, with assistance when requested from private industry representatives, prepare the Military Standards in the 300 to 399 series under the guidance of the JANAF Fuze Committee. During the preparation of a Standard, contacts are made with all laboratories concerned with designing and testing fuzes, and contributions of test information are solicited. The many laboratories and the numerous engineers within these laboratories have their own versions of each particular test which differ slightly from the versions of others. The committee carefully selects the most favorable factors of each version and makes these a part of the Standard. Prior to publication the proposed MIL-STD's are coordinated with the three services. In view of the thoroughness in preparation of a Standard, the previously quoted promulgation appears to be justified. It is the desire and intent that when the decision is made to apply the Standard to a particular fuze, the Standard must be carried out without any deviation.

Content of Military Standards. Each Military Standard prepared by the fuze committee establishes the purpose, scope, criteria, and procedure to guide the user after the decision has been made to apply the test. The intent of the committee is to use the development series (300-349) of tests on samples manufactured in accordance with the final version of the design. The production series (350-399) is for use in testing samples of fuzes from a production lot. These tests are not intended for use in lieu of other inspection methods, and all tests in the series would probably never be used on one test program.

Single Tests. The Military Standards in this series establish only one specific test in each Standard as opposed to the system used in some series which describe several tests in one Standard. For example, MIL-STD-302, Forty Foot Drop Test, established a procedure, equipment, test parameters, and a criterion for passing or failing the test. The 300 series has become known as individual tests, and the number is sufficient to identify the test. Many suggestions have been made to include several tests or variables in a Standard such as a drop test, with a choice of drop heights and impact media. The committee has repeatedly expressed the opinion that the advantage of single test identification outweighs the advantage of holding down the number of Military Standards. The committee is well aware that exceptions may be necessary and if the need arises, the committee can and will approve multiple test documents.

Sample Size. The policy of the Committee has been to establish the criteria for a single fuze and no attempt has been made to specify sample sizes for reliability and safety requirements with respect to the design or production specifications. Only in those tests where several positions are necessary is any mention made of numbers of fuzes. For example, the Forty Foot Drop Test and the Salt Spray (Fog) Test, MIL-STD-302 and 306, respectively, require several fuzes to fulfill all of the position requirements. The sample size, safety, and reliability requirements and related information should be supplied in the particular item specification. Exception to the policy may be necessary when a test requires a minimum sample size to accomplish the purpose. It is assumed that should such a test be developed, an exception will be made.

Selection and Application. The decision of whether or not to apply a Military Standard to a particular fuze design is of the utmost importance. Many factors must be weighed in the decision. Frequently, a misunderstanding of the promulgation in each Standard has incorrectly affected the decision. The meaning and intent of the following statement must be considered: "This Standard has been approved by the Department of Defense and is mandatory for use by the Departments of the Army, the Navy and the Air Force...". The promulgation does not and never did intend to imply that any Standard must ever be used. Its use is mandatory only when the Standard has been selected as applicable and its use has been directed by proper authority. After the MIL-STD has been selected as applicable, deviations from the requirements are not permitted. Conversely and even more emphatically, users are cautioned that passing all Military Standards in the 300 series does not automatically insure a safe or reliable design.

An anti-aircraft fuze designed for air burst with a self-destruction device included would not be tested in accordance with MIL-STD-307A, Jettison (Aircraft Safe Drop) Test for Use in the Development of Fuzes, but it might very well be tested in accordance with MIL-STD-312, Muzzle Impact Safety Test for Use in Development of Projectile Fuzes. On the other hand, a decision must be made with respect to MIL-STD-314, Waterproofness Test for Use in Development of Fuzes. If the requirement for leak tightness is in excess of that which can be detected by the Waterproofness Test, a proper and applicable leak test must be specified and MIL-STD-314 should not be used.

Criteria. The criteria in several Military Standards contain a statement to the effect that the decision that the fuzes have met, or failed to meet, the criteria is based on breakdown, inspection, and appropriate tests, together with engineering judgment. One might ask how this is accomplished and who is qualified to exercise the engineering judgment. The committee has not established any definitions, but it is generally agreed that a fuze design and evaluation (or test) laboratory will have a competent and experienced staff to accomplish this general requirement.

The committee is reluctant to write the criteria in more restrictive terms, especially in the tests for use in development of fuzes, because such a test would have more limited application and hence less value in development and design of fuzes. A detailed engineering report of the test results and unusual observations is of immeasurable use in the exchange of information between laboratories and services.

Test Engineering. There may be some situations in which the presence of explosives endangers the test equipment or test personnel, or after the test, disassembly of a loaded fuze under safe conditions may be impossible. The engineer in charge must examine the fuze design, the test equipment, and test criteria before making his decision on how to conduct the test. The criteria in many tests suggest that disassembly of the loaded fuze after the test may be advisable to determine whether the fuze passed or failed the test. A particular design may make disassembly highly impractical, and the test engineer must then devise other means of assessing results, such as the use of radiography. The information and procedural directions in the Military Standard are not a substitute for experience, initiative, ingenuity and judgment.

The existence of this series of tests for fuzes should not restrict the experimental or design engineer because he should always exercise initiative in exploring specific problem areas. Recently in a test program of a sealed fuze, failures occurred after the Temperature and Humidity test, MIL-STD-304. Suspicion was cast on the integrity of the seals, even though the fuze had been checked with a helium mass spectrometer before and after the Temperature-Humidity test and found leak proof. Immediately, several fuzes were used in experiments to reveal the specific causes of failures which had been masked in the combined environment cycling test. A seal was found to open slightly due to the differential expansion of adjoining materials. This was revealed when a leak test was conducted at -65°F. Experiences of this type emphasize the value of non-standard experiments tailored to the problem area. When defects or deficiencies are revealed in the final test program, the validity of the Military Standard tests is enhanced.

Non-Standard Tests. The committee expects non-standard engineering tests to be conducted during the development, design, evaluation, and proof phases to prove specific or particular design ideas. The tests may resemble the Military Standard tests, but the test engineer should use his initiative in modifying the tests. The exceptions may be that no explosives are used, the height of drop is increased or lowered, the vibration time or frequency range may be varied, or the temperature or humidity may be altered. These deviations from the Standard are to be expected. It is by these modified tests that the designer obtains information on which to base alterations or to freeze his design. Eventually the design should be capable of meeting the criteria of the applicable Military Standard tests without exception. Even at this point, the engineer may wish to include tests in the program which use factors of greater magnitude or severity than established in the Standard, or he may wish to use samples without explosives. The committee encourages this procedure if useful information is thus made available to the engineers. However, the Military Standard test conducted without exception is generally the only basis for the exchange of information between laboratories and services. When a Standard is not followed, the test report should be explicit in describing the procedure used.

Two examples are cited to illustrate the problems encountered in the simulation of service environments.

(1) A mechanical time, projectile fuze passed the "Forty Foot Drop Test," MIL-STD-302 but the test engineer studied the design and questioned the fail-safe feature at a lesser shock. A series of tests at drop heights between 5 and 40 feet showed that the fuze consistently armed on a 15 foot drop. It armed less consistently as the height was increased or decreased and met the criteria of the "Five Foot Drop Test," MIL-STD-358 and the "Forty Foot Drop Test".

(2) An impact fuze passed the "Forty Foot Drop Test," MIL-STD-302 but armed when dropped 15 feet onto a soft surface such as friable soil. A device which must operate (arm) on a low setback force of long duration may arm when dropped onto a soft surface unless a discriminating feature is included.

Design of fuzes to meet the military requirements is difficult but many fuzes have been designed to meet the requirements and are in service use. These fuzes are rugged and safe so that they will withstand normal and accidental rough handling without endangering personnel and equipment. Yet, when these fuzes are employed in the service usage for which they were designed, the fuzes arm and function with an extremely high reliability.

PROGRAM PLANNING

A fuze design project may be initiated by an Ordnance Committee Meeting Item, Military Requirement, or other document which sets forth the intended logistical and tactical requirements. From this source of information, the design goal and environmental criteria may be established. The project engineer generally establishes a program of tests and data analysis procedures which will be used for evaluation when the design has been finalized. The evaluation program thus established is generally used as a guide for engineering tests to be conducted during the development and design phases. The designer may conduct engineering tests which resemble but do not duplicate the evaluation test because he does not have complete devices for the interim type test. However, during the design phase of the program, many tests may be conducted to determine that the design will meet the military requirements. The various kinds of tests may far exceed those planned for the final evaluation program. When the design is ready for evaluation, the number of tests generally are limited to a reasonable minimum number to establish the reliability of functioning and the degree of safety.

Frequently the Military Standard tests have been used to define environmental criteria or design goals. This is undesirable because a test standard may be limited in its application that it may not fully define or establish a specific environment. If the approach of listing Military Standards is used, the design engineers and evaluation engineers might feel limited to testing against only those Standards. For example, a military requirement or environmental criteria document which states that a fuze must pass the Temperature and Humidity test, MIL-STD-304, and Salt Spray (Fog) test, MIL-STD-306, is less useful a design tool than is a document which delineates the anticipated environmental and operational extremes. If the latter description is used in the document, the engineer or scientist in charge may select several Military Standard tests and will very likely find that he must also use other tests unique to the application.

SELECTION OF MILITARY STANDARDS

A study of the military requirements or environmental criteria document by an engineer will provide the basis for selecting a series of laboratory and field tests to be used in the evaluation program. Military Standard tests should be used when applicable and non-Military Standard tests should eventually become Military Standards if they have repetitive and broad application. Concurrent with this study, sample sizes should be determined to establish the degree of conformance in reliability and safety required by the program. It is not expected that all Military Standard tests in the 300 or 350 series apply to any one fuze design; however, it is mandatory that the engineer use the Military Standard in preference to a non-Military Standard whenever the Standard will provide the necessary data.

COMBINED ENVIRONMENTS

Combined environments are usually necessary for testing, and yet the simplest combination offers so many possible conditions that a Standard test is not generally practicable. Some Standards have been written combining the more frequently encountered or prevalent environments. However, it is expected that the engineer will plan the program to combine environmental tests as indicated by the military requirements or environmental criteria for the specific fuze.

Complex assemblies make the selection of environments to be controlled in a test a difficult problem and generally complex equipment for conducting the test may be necessary. As an example, a weapon containing a battery, when vibration tested at -65°F, failed due to breakage of the wires to the battery terminals. This defect had not been observed in vibration tests at room temperature because the battery was loosened in its container only by differential contraction at the low temperature. Correction was accomplished by the installation of low-temperature rubber spacers.

Shock tests at low temperatures are generally more severe on structures than the same shock test at room temperature unless the designer has painstakingly selected materials for the specific condition. Increased brittleness and hardness of ferrous metals and non-metallic materials at low temperatures generally create a less shock resistant assembly.

Combined tests of vibration and acceleration have been conducted by mounting a vibrator on the arm of a centrifuge. The temperature has also been controlled by mounting electrical radiant heaters around the test item. These combinations are far from standard at present and the tests have been formulated to obtain a particular set of operational data on a fuze component under development for a special weapon.

An underwater weapon fuzing device containing a pressure-safety, impact-operational feature was tested by combining pressure and acceleration tests. A pressure vessel containing the test item was attached to the table of a drop tester thus providing regulation of the two environments.

These examples illustrate the extent to which the environment simulation technology has progressed. When any of these tests or procedures are ready for standardization or are used repeatedly, the information should be published as a Military Standard or Journal Article.

INFORMATION SOURCES

In the past, the records of studies leading to the publication of a Military Standard have been placed in the committee files without publication. It is the intention of the committee to publish a JANAF Fuze Journal Article summarizing each future study which results in a Standard. The articles are intended to be informative and are not to be used in procurement as contractual documents. The Fuze Committee welcomes suggestions regarding its efforts and will attempt, within its capability, and mission to undertake suggested studies or prepare additional tests and journal articles. Several tests and articles are in process at all times. Contact with the committee and subcommittees is quite easy because there are members on the committee from all fuze development laboratories which are directly managed by the Department of Defense.

Copies of the Journal Articles are on file at the DOD Laboratories involved in fuze development, and at Armed Services Technical Information Agency (ASTIA), Document Service Center, Arlington Hall Station, Arlington 12, Virginia.

Copies of the Military Standards may be obtained for other than official use by individuals, firms, and contractors from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Copies for official use in connection with specific procurement functions should be obtained from the procuring agency or as directed by the contracting officer.

REFERENCES

(a) JANAF Fuze Committee. Introduction to the Use of Military Standards, JANAF Fuze Committee Journal Article Serial No. 01.0, 23 August 1955.

(b) Headquarters, Department of the Army. Army Regulation No. 705-15, Research and Development of Materiel.

(c) Bureau of Naval Weapons. NavOrd OS 6341, Miscellaneous General Ordnance Design Requirements.

(d) Erickson, A. H. Fuze Testing Standards, Ordnance, p 1050, 3pp, May-June 1954.

TABLE 1

NO.	TITLE
MIL-STD-300	Jolt Test for Use in Development of Fuzes
MIL-STD-301	Jumble Test for Use in Development of Fuzes
MIL-STD-302	Forty Foot Drop Test for Use in Development of Fuzes
MIL-STD-303	Transportation-Vibration Test for Use in Development of Fuzes
MIL-STD-304	Temperature and Humidity Test for Use in Development of Fuzes
MIL-STD-305	Vacuum-Steam-Pressure Test for Use in Development of Fuzes
MIL-STD-306	Salt Spray (Fog) Test for Use in Development of Fuzes
MIL-STD-307a	Jettison (Aircraft Safe Drop) Test for Use in Development of Fuzes
MIL-STD-308	Jettison (Simulated Aircraft Safe Firing, from Ground Launcher) Test for Use in the Development of Rocket-Type Fuzes
MIL-STD-309	Jettison (Simulated Aircraft Safe Drop, from Ground Launcher) Test for Use in the Development of Fuzes
MIL-STD-310	Jettison (Aircraft Safe Firing) Test for Use in the Development of Rocket-Type Fuzes
MIL-STD-311	Accidental Release (Low Altitude, Hard Surface) Safety Test for Use in the Development of Fuzes
MIL-STD-312	Muzzle Impact Safety Test for Use in Development of Projectile Fuzes
MIL-STD-313	Impact Safe Distance Test for Use in Development of Fuzes
MIL-STD-314	Waterproofness Test for Use in Development of Fuzes

NO.	TITLE
MIL-STD-315	Static Detonator Safety Test for Use in Development of Fuzes
MIL-STD-316	None
MIL-STD-317	Detonator Output Measurement by the Lead Disc Test
MIL-STD-318	Missile Pull-Off from Aircraft on Arrested Landing (Ground Launcher Simulated) Safety Test for Use in Development of Fuzes
MIL-STD-319	Time to Air Burst Test for Use in Development of Projectile Time Fuzes
MIL-STD-320	Terminology, Dimensions, and Materials of Explosive Components for Use in Fuzes (Same as MIL-STD-638)
MIL-STD-321	Jettison (Aircraft Safe Drop) Test for Use in Development of Fuzing Systems
MIL-STD-350	Jolt Test for Use in Production of Fuzes
MIL-STD-351	Jumble Test for Use in Production of Fuzes
MIL-STD-352	Forty Foot Drop Test for Use in Production of Fuzes
MIL-STD-353	Transportation-Vibration Test for Use in Production of Fuzes
MIL-STD-354	Temperature and Humidity Test for Use in Production of Fuzes
MIL-STD-355	Vacuum-Steam-Pressure Test for Use in Production of Fuzes
MIL-STD-356	Salt Spray (Fog) Test for Use in Production of Fuzes
MIL-STD-358	Five Foot Drop Test for Use in Production of Fuzes